SHOCK-INDUCED DEFORMATION FEATURES IN TERRESTRIAL OLIVINE AND LUNAR DUNITE*; Lawrence W. Snee and Thomas J. Ahrens, Seismological Laboratory, California Institute of Technology, Pasadena, California 91125

The dunite clast, 72415 (age ~4.6 AE) may originate from a deeply buried early cumulate which was excavated via major impact[1]. Comparison of textures and planar fracture populations with a similar composition terrestial peridot, shocked in the laboratory, indicates that 72415 experienced a shock pressure in the range 330 to 440 kbar. Single crystals of peridot ($\sim Fo_{90}$) ~5 x 3 x 0.5 mm, were directly impacted along (010) with a series of gun launched, tungsten plates (18 mm diameter, 2.5 mm thick) bearing lexan projectiles. For impedance matching purposes, the rear and lateral surfaces were imbedded in hot-pressed NaBr pellets. Induced shock pressures were determined from measured impact velocities using an impedance match solution[2] and equations of state for olivine[3] and tungsten[2]. Orientations of extensive populations of planar fractures in the experimentally shocked and lunar olivine were measured (Table 1, Figure 1) using mounted and polished grain mounts in a universal stage microscope. Undulatory extinction in all samples gave rise to general orientation uncertainty of ± 10°. Three terrestrial samples demonstrate a distinct decrease with shock pressure in the percentage of pinacoids {100}, {010} and{001} and prisms {hk0}, {0h1} and {h01}, while the percentage of bipyramids increased with shock pressure. In the 280 kbar sample, irregular fractures, and some planar elements, in addition to open fractures are observed. Most fractures are along pinacoids or prisms and the few {hkl} pyramids lie near the h = k band. The 330 kbar sample showed deformation bands and some minor mosaicism and recrystallization. There is a distinct increase in bipyramids, while the number of pinacoids decreases and prisms remain approximately the same as in (a). The majority of bipyramids lie near the h = k and the h = 2k planes. Some grains from the 440 kbar sample were completely recrystallized. The percentage of bipyramids increase with increasing pressure while the percentage of pinacoids and prisms decrease. Further, the complexity of the distribution of bipyramids increases, although there are several points near the 3h = k plane. The preponderance of prisms near {130}observed by others[4,5] in terrestrial and lunar olivine were not detected.

The lunar dunite has well developed deformation bands, planar elements and minor mosaicism and a very few completely recrystallized grains. The population of fracture orientations appears to be between those observed in the 330 and 440 kbar samples (Table 1). However, many of the {hkl} bipyramids occur along 2h = k planes, a population not obviously predominant in the laboratory-shocked samples. Hypervelocity flow calculations[6] describing the mass distribution of lunar rock subjected to various shock pressures, for an impact capable of excavating the Imbrium crater, demonstrate that the maximum depth of origin of a dunite, such as 72415, subjected to a ~350 kbar shock, is approximately ~50 km.

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Table 1. Planar fractures in shocked-loaded peridot and lunar dunite, 72415

Impact Velocity (km/sec)	Shock pressure (kbar)	No. of grains	No. of fracture sets	Crystallographic Orientation of Planar Fractures: Pinacoids {100}	{010}	{001}	%	Prisms {hko}	{okl}	{hol}	%	Bipyramids {hkl}	%
1.41±0.02	280±5	9	40	6	6	5	42.5	7	7	1	37.5	8	20
1.67±0.02	330±5	15	67	4	7	7	27	12	1	11	36	25	37
2.14±0.02	444±5	11	50	5	6	3	28	5	5	2	24	24	48
	Lunar dunite, 72415	10	45	5	2	6	29	5	5	5	33	17	38

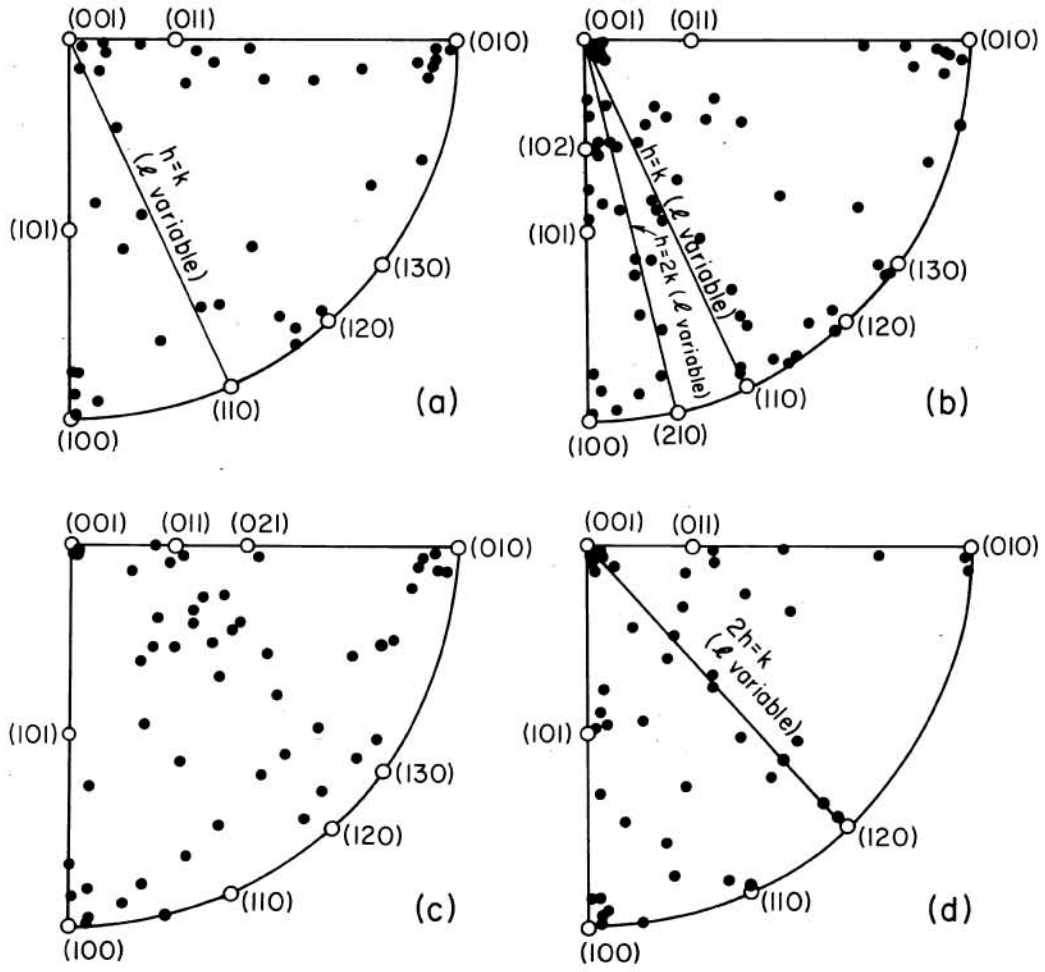

Fig. 1. Stereographic projections of planar fracture orientations. (a), (b) and (c) terrestrial olivine shocked to 280, 330 and 440 kbar. (d) olivine from 72415.